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Investigating Motorists’ Behaviors in Response to Supplementary Traffic Control Devices at Land Surveying Work Sites

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Objective: Since land surveyors working alongside live traffic encounter unique safety challenges there is a great need for innovative and effective traffic control devices (TCDs) that alert motorists approaching short-term land surveying work sites. Unlike the volume of research that has been completed on traditional work zones, however, there is a limited amount of information that has been collected on how motorists respond to TCDs at land surveying work sites. This article aims to fill the void by investigating motorists’ behaviors in response to the use of 2 supplementary TCDs at land surveying work sites: portable plastic rumble strips (PPRS) and warning lights.

Method: Extensive field tests were conducted at various land surveying work sites on 2-lane 2-way urban roadways in New Jersey. Scenarios with and without the use of the supplemental TCDs were designed. Motorists’ behavior changes were then statistically examined by using surrogate safety measures including mean speed, speed variance, speed limit compliance, and braking action.

Results: Statistical analyses showed that the traffic speed variations did not significantly increase when the selected supplemental TCD was used; rather, motorists significantly reduced their driving speed. When warning lights and PPRS were separately deployed at the land surveying work sites the average reduction in mean speed was 6.7 and 15.2 percent, respectively. The mean speed was reduced by 19.7 percent when both of these supplementary TCDs were used. Logistic regression models developed to examine the speeding and braking behavior also showed that motorists were more likely to comply with the speed limit and increase their braking rate when the selected TCDs were used.

Conclusion: The use of supplemental TCDs can greatly contribute to the changes in motorists’ behaviors at surveying work sites. The changes in motorists’ driving behaviors imply that the motorists reacted favorably to the deployed TCDs at the land-surveying work sites.

Keywords: surveyor safety, motorists’ behavior, work sites, traffic control device, rumble strip, warning light

Introduction

Land surveyors who conduct short-term roadway surveying work face unique safety problems because they are frequently exposed to live traffic and usually no lower speed limits are enforced at their work sites (Glassy 2004; Ozbay et al. 2013). Approaching motorists are often unaware of upcoming short-term temporary work sites, and this often puts surveyors, as well as motorists, at risk. More specifically, these surveyors are at risk because of motorists’ aggressive driving, speeding, and errant driving behaviors (Glassy 2004; Michigan Fatality Assessment and Control Evaluation 2007; National Institute of Occupational Safety and Health 2011). If a surveyor were to be involved in a crash, he or she would very likely be seriously injured or killed (Kim 2011; WRDW-TV 2011). As is the case at other short-term work zones, it is necessary to provide adequate advance warning to motorists to reduce their speed, increase their awareness to the approaching work sites, and mitigate the risk of a crash. However, many of the standard traffic control devices (TCDs) used in traditional, stationary work zones are unsuitable for surveyor work sites. This is because land surveyors’ work sites usually cover a large area within which surveyors constantly move around to take measurements and the duration of their work is relatively short (Ozbay et al. 2013). Common traffic control and safety devices used in land surveying work sites include traffic cones,
Survey Crew Ahead signs, reflective vests, and flags. Although these safety devices are helpful, it is worth using additional devices that can be deployed quickly and easily while further improving the safety of both land surveyors and motorists at the same time.

The objective of this article is to investigate motorists’ behaviors in response to the use of two supplementary TCDs at land surveying work sites: portable plastic rumble strips (PPRS) and warning lights. Unlike previous studies that focused solely on traditional work zones, we attempted to identify whether additional TCDs would affect motorists’ behaviors at land surveying work sites and, if so, how effective they will be. To achieve this goal, extensive field tests were performed at land surveying work sites located on 2-lane 2-way urban roadways in New Jersey.

The next section of this article provides a brief review of the existing studies on traffic control and safety devices used to change motorists’ behaviors at work zones, in addition to a review of the practical guidelines used by state transportation departments for surveyor safety. Then, a description of the study methodology is presented, followed by the field evaluation results. Major findings of our analyses are summarized in the final section.

Literature Review

Many studies have focused on investigating the impact of TCDs on motorists at traditional work zones. For instance, Fontaine (2006) tested the impact of a speed display trailer, a radar drone, portable rumble strips, alternative work vests, and roll-up orange signs at rural short-term maintenance work zones. Finley et al. (2001) studied the impact of a flashing warning light system for work zone lane closures. Theiss et al. (2010) conducted field studies to determine the operational effectiveness of electronic speed limit signs and flexible roll-up speed limit signs at short-term work zones. Shaaban et al. (2011) assessed a dynamic lane merging system at a short-term work zone lane closure. Finley et al. (2006) investigated motorist comprehension of static signs, dynamic mobile speed displays, and mobile signs for mobile operations in Texas. Hajbabaie et al. (2009) investigated the effects of 4 different speed management techniques for reducing speed in interstate highway work zones. Similarly, Oliveira et al. (2002) investigated the impact of radar transmissions on the mean speed of drivers. McCoy and Pesti (2001) evaluated the effects of condition-responsive reduced-speed-ahead messages on reducing traffic speed. Mattox et al. (2006) assessed the impact of a speed-activated sign on the reduction of 85th-percentile traffic speed and the percentages of vehicles exceeding the speed limit in work zones. Taken together, these studies provide insight into how to use traffic control and safety devices to influence motorists’ behaviors as they approach work zones. Unfortunately, there has been no study that specifically investigated the impact of TCDs at land surveying work sites.

For surveyors in the field, many state departments of transportation—such as the Florida Department of Transportation (DOT; Florida DOT 1999), Minnesota DOT (2000), and Illinois DOT (2001)—provide survey manuals and/or safety guidelines that address 3 primary topics relating to surveyor safety: personal protective equipment, traffic control devices, and other safety rules while working. These guidelines indicate that surveyors are required to wear high-visibility safety vests when working near vehicular traffic (Federal Highway Administration [FHWA] 2009). They are also required to use temporary traffic control and safety devices to provide the maximum level of safety for their crews and the traveling public when working on or adjacent to a roadway (Washington State DOT [WSDOT] 2005). The 2 basic types of traffic control devices, signs and channelizing devices, are frequently recommended by DOTs. (Principle advance warning signs such as “Survey Crew Ahead” have to be installed in accordance with Part VI of the Manual on Uniform Traffic Control Devices; FHWA 2012.) Surveyors may also use channelizers to warn and alert drivers of temporary land surveying work sites. In addition, flaggers using stop/slow paddles may be positioned as needed to warn motorists (WSDOT 2005). Additional traffic control devices such as arrow displays, variable message signs, and vehicle warning lights are sometimes recommended by the safety manual and guideline literature (Florida DOT 1999; WSDOT 2005), but none of these suggestions are required.

Today, motorists are frequently distracted by road signs, commercial signs (Dukic et al. 2013) and in-vehicle devices such as navigation screens and mobile phones (Farmer et al. 2010; World Health Organization 2011). Because of their distractibility, it is more important than ever to properly alert motorists to the presence of surveyors ahead. This need, however, has yet to be reflected in the literature. As our article’s literature review revealed, the research so far has mainly focused on the investigation of traffic control devices for the safety of construction and maintenance activities. More information on the impact of deploying TCDs for short-term land surveying work sites is needed.

Study Design

Supplementary Traffic Control and Safety Devices

Land surveyors determine horizontal and vertical locations of existing features and provide computer-aided design and drafting-based files. Land surveyor crews mostly work on local streets or county and state roads, where traffic speed limits often vary between 25 and 50 mph. They take horizontal and vertical readings of objects at different sites along roadways as shown in Figure A1 (see online supplement). They frequently move and take measurements adjacent to or in live traffic, as shown in Figure A1. To protect both surveyors and motorists, there are a wide variety of TCDs that surveyors may use while working near or in live traffic.

This study chose to focus on 2 TCDs to evaluate: PPRS and warning lights. These devices were identified after a review of the available devices in the market that may satisfy the specific conditions of surveyor work sites (Ozbay et al. 2013).

A PPRS is a type of temporary rumble strip made with engineered polymer material (Plastic Safety Systems 2011). Three sections (each 44 in. long, 13 in. wide, and 3/4 in. thick
Measuring Changes of Motorists’ Behaviors

The impact of the TCDs on motorists’ behaviors was examined by observing the changes in the motorists’ mean speed, speed variance, speed limit compliance rate, and braking rate.

There is overwhelming evidence in the literature that shows the positive correlation between vehicle speeds and the frequency and severity of pedestrian crashes. For example, the World Health Organization (Peden et al. 2004) reported that an average increase in speed of 1 km per hour (0.625 mph) is associated with a 3 percent higher risk of a crash involving an injury. The NHTSA (Leaf and Preusser 1999) reported that vehicle speeds predict both the frequency and the severity of pedestrian injuries. More specifically, approximately 5 percent of all pedestrian accidents are fatal when a pedestrian is struck by a vehicle traveling 20 mph; that rises to 40 percent for a vehicle traveling 30 mph and up to about 80 percent for vehicles traveling 40 mph. At speeds above 50 mph, the possibility that the accident will be fatal rises to nearly 100 percent.

The greater a vehicle deviates from the average speed of the traffic flow, the greater the chance that vehicle will be involved in a crash (American Association of State Highway and Transportation Officials 2004). Rosén and Sander (2009) found that the pedestrian fatality risk depends strongly on the impact speed, whereas others have found that the risk of such an accident increases in accordance with the variance in the vehicle speed (Garber and Gadiraju 1989; Lave 1985). As such, reducing a motorist’s speed and speed variance are both frequently used as indicators of motorists’ behavior changes in response to a traffic control device (Shaik et al. 2000).

Speeding is also one of the notable contributing factors in many work zone crashes, which further emphasizes the need for drivers to comply with posted speed limits in work zones (Brewer et al. 2005). Because this need exists, our study investigated motorists’ speed limit compliance rates by measuring the percentage of drivers traveling above the posted speed limit.

The proportion of vehicles that braked in their approach to the work site was also observed. It was assumed that drivers will be inclined to brake if they are aware of the presence of traffic control devices when approaching a work zone. The vehicles’ brake lights were monitored to identify the braking action in response to the deployed TCDs.

Statistical Analysis

Several statistical methods were used to examine the change in motorists’ behaviors in response to the TCDs. First, the $F$ test was used to test the equality of speed variances with and without a traffic control device. The null hypothesis ($H_0$) was that the use of a supplementary TCD does not affect the speed variances.

Second, the 2-sample $t$ test was used to test the equality of mean speeds with and without a TCD. The test followed the assumption that both samples were random, independent, and came from a normally distributed population with unknown

Data Collection and Test Plan

The selected devices were evaluated by way of 10 tests conducted at 6 distinct sites with land surveying crews from the New Jersey DOT. All of the test sites were at highway–rail grade crossings in different cities in New Jersey. Table A1 (see online supplement) presents the summary of the test sites. Each test site was a 2-way 2-lane roadway, where the speed limits varied between 25 and 40 mph, and hourly traffic volumes varied between 180 and 360 vph.

The 2 TCDs were deployed before the “Survey Crew Ahead” sign as supplementary devices to alert drivers as they approached a work site. Four test scenarios were designed:

1. “Survey Crew Ahead” sign only.
2. “Survey Crew Ahead” sign and warning lights.
3. “Survey Crew Ahead” sign and PPRS.
4. “Survey Crew Ahead” sign, warning lights, and PPRS.

Figure A3 (see online supplement) illustrates each scenario in the field. Scenario 1 was used as the base condition because it represents the typical traffic control setting of a land surveying work site. The other scenarios were used to evaluate the changes in motorists’ behaviors given the presence of the supplementary TCDs. When the warning lights were tested they were placed along the curb or shoulder so that the lanes were not blocked. This experimental setting is different from the deployment described in the Manual on Uniform Traffic Control Devices (FHWA 2012). When the PPRS were tested, 3 sets of rumble strips were placed in series perpendicular to the direction of traffic. They were deployed about 20 ft apart from each other.

All of the field tests were video-recorded and the postfield data processing was conducted in the laboratory to extract various traffic data including time stamp, vehicle type, speed, headway, and braking action for each vehicle. To avoid the confounding effects of the impact of vehicle platoons on the tested devices, only measurements of leading (free-flowing) vehicles (assumed with time headway no less than 4 s) were extracted. The total number of sampled vehicles was 3421, which represented more than 60 percent of all of the observed traffic during the 10 field tests. No previous studies have used such rich data for analysis.
Responses to Supplementary Traffic Control Devices

Table 1. Variables considered in speeding and braking action analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>Categorical</td>
<td>= 1 if vehicle is a truck; = 0 otherwise</td>
</tr>
<tr>
<td>Speed</td>
<td>Numerical</td>
<td>Observed speed of a vehicle (only used in braking model)</td>
</tr>
<tr>
<td>Speed limit</td>
<td>Categorical</td>
<td>= 1 if the posted speed limit is 40 mph; = 0 otherwise</td>
</tr>
<tr>
<td>Hourly volume</td>
<td>Numerical</td>
<td>The average hourly volume at the site</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Categorical</td>
<td>= 1 if there is a shoulder; = 0 otherwise</td>
</tr>
<tr>
<td>Warning lights</td>
<td>Categorical</td>
<td>= 1 if the lights are present; = 0 otherwise</td>
</tr>
<tr>
<td>PPRS</td>
<td>Categorical</td>
<td>= 1 if the PPRS is present; = 0 otherwise</td>
</tr>
<tr>
<td>Warning lights + PPRS</td>
<td>Categorical</td>
<td>= 1 if both devices are present; = 0 otherwise</td>
</tr>
</tbody>
</table>

Results and Discussion

Change in Driving Speed

Table A2 (see online supplement) shows the measured mean speed and speed variances when different TCDs were presented. The test results show that the null hypothesis cannot be rejected for all scenarios, except the ninth test in scenario 2 and the first test in scenario 4 at a significance level of .05. During the ninth test in scenario 2 and the first test in scenario 4 the speed variations were reduced by 1.9 mph, \( F(86, 105) = 1.810, P = .004 \), and 1.80 mph, \( F(61, 49) = 1.842, P = .029 \), respectively. Therefore, these results suggest that neither individual deployment nor the combined use of the 2 devices adversely affected the stability of traffic flow. Table 2

The mean speeds were compared among selected scenarios. A general trend in the reduction in mean speed is observed in Table A2. When the warning lights were deployed (scenario 2), the 2-sample t test confirmed that the mean speeds in 6 tests were significantly reduced compared to scenario 1. The maximum reduction was 13.6 percent. The average reduction for all field tests was 6.7 percent. When a PPRS was deployed (scenario 3), significant reductions in the mean speed were observed in all but the first test. The maximum reduction was 28.5 percent and the average reduction for all tests was 15.2 percent. When the warning lights and PPRS were used together (scenario 4), the reduction in the mean speed was at its highest: all sites had significant reductions ranging from 7.0 to 35.8 percent. The average reduction of all tests in scenario 4 was about 19.7 percent. Figure 1 presents the results in terms of both absolute and percentage changes in mean speed when the test sites were grouped by speed limit. The results showed that, overall, the tested TCDs performed better in terms of speed reduction on roads with a 25 mph speed limit. In addition, the PPRS performed better than the warning lights. The combined use of these devices decreased the mean speed by 15.8 and 25.8 percent for roads with 40 and 25 mph speed limits, respectively. Table 3

To sum up, the use of the tested devices generally reduced the mean speeds of motorists at these test sites. The PPRS outperformed the warning lights in terms of reducing mean speeds at more of the test sites, and the use of the warning lights and PPRS together further enhanced the reduction in mean speeds overall. As discussed, reduced vehicle speeds can lead to improved safety for both drivers and land surveyors at the temporary work sites (Leaf and Preusser 1999; Peden et al. 2004). The reduction in mean speeds indicates that the variance. Although the sample sizes and variances of each group may have been equal, it was not a requirement of the study. If the assumption of equal variance was valid, the Student’s t test could be used. Otherwise, Welch’s t test was used. The null hypothesis (H0) was that the motorists’ mean speeds did not change when a supplementary TCD was deployed.

Finally, both the differences in the proportions of vehicles traveling over the speed limit and vehicles braking under each scenario were tested using Fisher’s exact test. For speed limit compliance analysis, the null hypothesis (H0) was that the deployment of a TCD does not change the proportion of speeding vehicles. Similarly, the null hypothesis (H0) for braking behavior analysis was that motorists did not change their braking behavior when a supplementary TCD was deployed at a land surveying work site. All tests were conducted at a significance level of \( \alpha = .05 \).

Motorists’ actions including speeding and braking were further examined given the presence of TCDs. Each action has been denoted as a dichotomous outcome (e.g., \( y = 1 \) for speeding and \( y = 0 \) for not speeding; similarly, \( y = 1 \) for braking and \( y = 0 \) for not braking) for when a vehicle approached the surveyor work site. A binary logistic regression model was developed to examine the influence of not only the control devices but also factors that affected the probability of a vehicle speeding and/or braking at the sites. Detailed description of logistic regression model is available in a number of references such as Menard (1995) and Hosmer and Lemeshow (2000). The probability \( \pi(x) \) that a vehicle traveled above the speed limit or was braking can be described by the logistic distribution shown in following equation:

\[
P(y = 1|X) = \pi(x) = \frac{\exp(\alpha + X'\beta)}{1 + \exp(\alpha + X'\beta)},
\]

where \( \pi(x) \) is the conditional probability of the form \( P(y = 1|X) \); \( X \) is the vector of contributing factors at surveying work sites; \( \beta \) is the corresponding vector of the coefficients; and \( \alpha \) is the intercept parameter.

The variables considered for speeding and braking behavior modeling are listed in Table 1. Note that speed is only included in the braking behavior model.

Table 2. Speeding action modeling results

| Variable          | Estimate | SE  | z Value | Pr(>|z|) | Odds ratio (95% CI) |
|-------------------|----------|-----|---------|----------|---------------------|
| Intercept         | 2.455    | 0.251 | 9.788   | <2e−16   | -                   |
| Truck             | −1.712   | 0.110 | −15.636 | <2e−16   | 0.180(0.145,0.223)  |
| Speed limit       | −3.188   | 0.159 | −20.079 | <2e−16   | 0.040(0.030,0.056)  |
| Hourly volume     | −0.002   | 0.001 | −2.399  | 0.016    | 0.998(0.996,1.000)  |
| Shoulder          | 1.384    | 0.162 | 8.578   | 7.28e−09 | 5.628(4.585,8.657)  |
| Warning lights    | 0.685    | 0.118 | 5.978   | 0.056    | 1.996(1.589,2.493)  |
| PPRS              | −1.247   | 0.116 | −10.720 | <2e−16   | 0.280(0.229,0.361)  |
| Warning lights + PPRS | −1.550   | 0.120 | −12.933 | <2e−16   | 0.212(0.167,0.268)  |
motorists reacted favorably to the deployed TCDs. To further confirm the effectiveness of the TCDs in subsequent studies, it would be beneficial to interview the motorists on their awareness of the TCDs.

**Change in Speeding Behavior**

Fisher’s exact test was used to statistically examine the null hypothesis that the proportions of speeding vehicles did not change when the selected TCDs were deployed. The results show that the proportions of speeding vehicles were reduced when additional TCDs were deployed. Specifically, 4 out of the 10 tests showed significant reductions in the proportion of speeding vehicles under scenario 2 (“Survey Crew Ahead” sign and warning lights). In contrast, when PPRS or PPRS with the warning lights were used, significant reductions in speeding vehicles were observed in all but the first field tests. More specifically, the PPRS or the PPRS with the warning lights reduced the proportion of speeding vehicles to less than half the number of vehicles that were speeding when only the “Survey Crew Ahead” sign was used.

Table 2 shows the modeling results for the speed limit compliance analysis. Compared to using the “Survey Crew Ahead” sign, the use of the warning lights or the PPRS greatly decreased the odds of speeding. The deployment of the warning lights, PPRS, and their combination resulted in odds ratios (ORs) of 0.504, 0.287, and 0.212, respectively. The small ORs (<1.0) suggest that the deployment of the selected traffic control devices is relatively effective; in particular, the combined use of the warning lights and PPRS resulted in the highest effect.

![Fig. 1. Speed changes on roads with different speed limits.](image)

It can also be seen that if the vehicle is a truck, it is less likely to exceed the speed limit. Specifically, the OR of a truck versus a car is 0.180. Interestingly, the OR of roads with a speed limit of 40 mph over the roads with a speed limit of 25 mph is 0.041. This difference might be attributed to the relatively low speed limit (e.g., 25 mph) for the one-lane test sites. Motorists can easily exceed the speed limit at nonresidential sites with such low speed limits. One unit increase in the average hourly volume slightly reduces the odds of speeding.

**Change in Braking Action**

Fisher’s exact test was used to test the null hypothesis that the use of a selected TCD does not change motorists’ braking behaviors. When no control devices were used, the proportions of vehicles braking ranged from 2.3 to 21.3 percent (see Table A2). When the warning lights were used, the braking rate increased significantly in 4 out of the 10 tests, from 8.1 to 12.8 percent. Increases ranging from 1.1 to 11.3 percent were also observed in other tests, but they were not statistically significant.

As shown in Table A2, except for the first test, the braking rates significantly increased when the PPRS were used. The braking proportions ranged from 9.2 to 40.3 percent. If PPRS and warning lights were used at the same time, the braking rates in all tests were further increased. The braking rates under scenario 4 ranged from 19.2 to 45.5 percent.

Table 3 presents the modeling results of the braking behavior change in relation to different variables. The OR of braking for a truck versus a car was 0.739. These results suggest that trucks were less likely to brake than cars at surveyor work sites. This is because most trucks were already traveling slower than the passenger cars. One unit increase in the speed decreased the odds of braking by 3.2 percent. On roads with speed limit of 40 mph, the odds of braking were 0.652 of that on roads with speed limit of 25 mph. An increase in the average hourly volume slightly reduced the odds of braking. The presence of a shoulder did not significantly change the ORs of braking. When additional TCDs were present, the odds of braking were about 2 to 4 times higher.

Based on these results, it can be observed that the supplementary TCDs increased the proportion of braking vehicles. Motorists were more likely to brake when the PPRS or the PPRS and warning lights together were deployed.

To enhance the safety of surveyors, additional TCDs that are easy to use, effective, and inexpensive should be deployed. Among the various advanced traffic control and safety devices on the market, 2 commercially available, easy-to-install devices—warning lights and PPRS—were evaluated in this study. They were tested at 6 land surveying work sites on 2-lane 2-way urban roadways in New Jersey. Motorists’ behaviors in response to these supplementary TCDs at short-term surveying sites were comparatively examined through 4 designed experiments in each field test. A set of indicators extracted
from the videos collected in the field was used to statistically quantify the change of motorists’ behaviors. These indicators included change in speed variation and mean speed, change in speed limit compliance, and change in braking rate.

The comparative results showed that the traffic was still relatively stable when the supplementary TCDs were presented because the devices did not significantly deteriorate speed variances. In addition, it was found that motorists significantly reduced their mean speeds when the TCDs were used at the work sites. When the warning lights were used, the average reduction in mean speeds was 6.7 percent. When the PPRS were used, the average reduction in mean speed was 15.2 percent. When both devices were used, motorists further slowed down, with an average reduction of 19.7 percent in mean speed. When deployed on roads with 25 mph speed limits, the devices performed better than on roads with higher speed limits.

The logistic regression model results indicated that motorists changed their speeding behaviors significantly when the supplementary TCDs were used. In particular, motorists were more likely to comply with the speed limit when the warning lights and PPRS were deployed together at the land surveying work sites. Similarly, the modeling results suggested that more motorists braked when they approached the short-term work sites with the use of the selected supplementary TCDs. The changes in driving behaviors imply that the motorists reacted favorably to the deployed supplementary traffic control devices at the short-term land surveying work sites.

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Supplemental Material

Supplemental data for this article can be accessed on the publisher’s website.

References


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